NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

JOINT APPLIED PROJECT

AN ANALYSIS OF BUSINESS PROCESS RE-ENGINEERING FOR GOVERNMENT MICRO-PURCHASING

By: Sharon M. Runde
September 2014

Advisors: **Magdi Kamel,**
Shelley Gallup

Approved for public release; distribution is unlimited.

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.			
1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** March 2014	**3. REPORT TYPE AND DATES COVERED** Joint Applied Project	
4. TITLE AND SUBTITLE AN ANALYSIS OF BUSINESS PROCESS RE-ENGINEERING FOR GOVERNMENT MICRO-PURCHASING		**5. FUNDING NUMBERS**	
6. AUTHOR(S) Sharon M. Runde			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000		**8. PERFORMING ORGANIZATION REPORT NUMBER**	
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A		**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**	
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB protocol number _____.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited		**12b. DISTRIBUTION CODE** A	

13. ABSTRACT (maximum 200 words)

This project examines the current business processes for micro-purchases within the government and analyzes the current processes with a potential "to be" system by utilizing business process re-engineering (BPR). The methodology includes a comparative analysis of BPR methodologies and tools, analysis of the current "as is" processes for the Naval Postgraduate School (NPS) micro-purchases, and the development of an improved "to be" processes. Data was gathered from various stakeholders in the purchasing process. BPR software was used to create use cases to study the process flow of the "as is" and "to be" systems.

The implementation of the process flow, workload, and information systems is highly individual to each agency. The efficiency, effectiveness, and transparency of procurements within individual agencies are highly dependent on leadership, experience, skill sets, training, information technology solutions, and human resources.

This research shows working models of improved cost, turn-around-time, and performance. The ultimate goal is to decrease the amount of time that it takes to complete the processes within the workflow system thus improving the turn-around-time for an end user to receive a product or service.

Upon completion of the analysis of the "as is" model and the "to be" model, savings in both cost and schedule were demonstrated. Re-engineering a few activities that were causing bottlenecks improved the total duration from approximately 20.96 days to 10.4 days. While the changes made are unique to the processes in place at NPS, the structure of BPR can be broadly applied across the government.

14. SUBJECT TERMS business process re-engineering, BPR, micro-purchasing, micro-purchase, business processes, business process model, methodology, business tools, BPR software			**15. NUMBER OF PAGES** 71
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UU

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited

AN ANALYSIS OF BUSINESS PROCESS RE-ENGINEERING FOR MICRO-PURCHASING AT THE NAVAL POSTGRADUATE SCHOOL

Sharon M. Runde
Civilian, Naval Postgraduate School
B.S., South University, 2009

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN PROGRAM MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
September 2014

Author: Sharon M. Runde

Approved by: Magdi Kamel
Thesis Advisor

Shelley Gallup
Second Reader

William R. Gates, Dean
Graduate School of Business and Public Policy

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

This project examines the current business processes for micro-purchases within the government and analyzes the current processes with a potential "to be" system by utilizing business process re-engineering (BPR). The methodology includes a comparative analysis of BPR methodologies and tools, analysis of the current "as is" processes for the Naval Postgraduate School (NPS) micro-purchases, and the development of an improved "to be" processes. Data was gathered from various stakeholders in the purchasing process. BPR software was used to create use cases to study the process flow of the "as is" and "to be" systems.

The implementation of the process flow, workload, and information systems is highly individual to each agency. The efficiency, effectiveness, and transparency of procurements within individual agencies are highly dependent on leadership, experience, skill sets, training, information technology solutions, and human resources.

This research shows working models of improved cost, turn-around-time, and performance. The ultimate goal is to decrease the amount of time that it takes to complete the processes within the workflow system, thus improving the turn-around-time for an end user to receive a product or service.

Upon completion of the analysis of the "as is" model and the "to be" model, savings in both cost and schedule were demonstrated. Re-engineering a few activities that were causing bottlenecks improved the total duration from approximately 20.96 days to 10.4 days. While the changes made are unique to the processes in place at NPS, the structure of BPR can be broadly applied across the government.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS AND ABBREVIATIONS

AO	authorizing official
BPM	business process management
BPR	Business Process Re-engineering
DFARS	Defense Federal Acquisition Regulation Supplement
DOD	Department of Defense
DMAIC	define, measure, analyze, improve, control
EJBs	Enterprise JavaBeans
FD	FastData
FAR	Federal Acquisition Regulations
GS	Government Service
GUI	graphical user interface
IT	information technology
JCA	Java Connector Architecture
JMS	Java Messaging Service
JIT	just in time
KFS	Kuali Financial System
LSS	Lean Six Sigma
MAS	Memorandum Accounting System
NAVAIR	Naval Air Systems Command
NPS	Naval Postgraduate School
NMCARS	Navy Marine Corps Acquisition Regulation Supplement
PCH	purchase card holder
PO	purchase order
SAP	simplified acquisition procedures
SPFA	sponsored program financial analyst
SPC	statistical process control
TQL	total quality leadership
TQM	total quality management

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGMENTS

I am deeply appreciative of the time and effort of my advisors, the stakeholders and their assistance with defining the current processes, the love and support from my friends and family, the boundless energy of “Major Trouble” while he gave me the much needed fetch sessions, and the patience of my son while I had “homework” to do. Every person (and pets) has contributed to the successful completion of this project. It would not be what it is today without every day having been what it was. I am truly grateful and blessed to be surrounded by wonderful people.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

A. BACKGROUND

The United States has been making procurements since its early inception as a government. One of the first acquisitions of the United States was the Louisiana Purchase. Since this controversial purchase of the Louisiana territory in 1803, government purchasing has undergone close scrutiny with resulting regulations in an attempt to minimize a governmental monopoly and maximize fair and open competition.

1. Federal Acquisition Regulation

The broadest regulations for the federal government are provided in the Federal Acquisition Regulations (FAR)

> The Federal Acquisition Regulation (FAR) is the primary regulation for use by all Federal Executive agencies in their acquisition of supplies and services with appropriated funds. It became effective on April 1, 1984, and is issued within applicable laws under the joint authorities of the Administration of General Services, the Secretary of Defense, and the Administrator for the National Aeronautics and Space Administration, under the broad policy guidelines of the Administrator, Office of Federal Procurement Policy, Office of Management and Budget. (GSA, Secretary of Defense, NASA, 2014).

Section 13 of the FAR prescribes the simplified acquisition procedures which are in most cases acquisitions under $3,000.

In addition to the FAR, government purchasing is also regulated by the Defense Federal Acquisition Regulation Supplement (DFARS). This project will specifically address micro-purchases within the Navy as implemented at the Naval Postgraduate School which is further governed by the Navy Marine Corps Acquisition Regulation Supplement (NMCARS).

2. Defense Federal Acquisition Regulation Supplement

The Defense Federal Acquisition Regulation Supplement further refines the FAR and is specifically aimed at the Department of Defense (DOD), as opposed to other federal agencies that are not part of the DOD. Part 213 of the DFARS addresses Simplified Acquisition Procedures (SAP) and closely mirrors the regulations of the FAR. The DFAR explains in further detail the authorized use of using government-wide commercial purchase card and the exceptions to the FAR. In order for a contract action to be handled differently from the FAR procedures, the purchase exception must be approved by the Deputy Secretary of Defense, a general or flag officer or Senior Executive Service (SES), and the purchase must meet certain criteria (DAR Council, 2014).

3. Navy Marine Corps Acquisition Regulation Supplement

For the purposes of this research, the final layer of regulations that must be adhered to is the Navy Marine Corps Acquisition Regulation Supplement (NMCARS). These regulations supplement the FAR and DFAR and specifically address the Navy Marine Corps branch of service (Department of the Navy, 2013).

B. PROBLEM STATEMENT

The obvious problem is that there are mountains of regulations for government purchasing. With more regulations and revisions made to the policies throughout the year, workflows and business processes can quickly become muddied. The Federal Acquisition Regulation (FAR) and all applicable supplements address various legislation, policy, and guidance for government purchases. However, the implementation of the process flow, work load, and systems used to achieve the end results of procurements is highly individual to each agency and institution. The efficiency, effectiveness, and transparency of procurements within individual institutions is highly dependent on the leadership of the institution, experience, skill sets, training, information technology solutions, and human resources.

The average end user may have little or no knowledge of the regulations or the steps involved in how purchasing is accomplished. Despite an end users' level of knowledge of the regulations, this does not preclude the end user from having a requirement for a product or service. The end user must budget and plan for the delivery of a product or service, and must use a system in order to accomplish mission goals and objectives. The end user must work together with the personnel involved in procuring requirements within the limits of the leadership, experience, skill sets, and training of the human resources within the workflow. The system currently in place that the end user has available for use attempts to provide a structure and electronic workflow to submit a requisition while allowing for transparency, accuracy, and timeliness. Even with the best information system, if business processes are not implemented to optimize the workflow and avoid or minimize bottlenecks, the entire process can fail.

1. Problem Identification

This study examines micro-purchases at the Naval Postgraduate School (NPS). Prior to 2009 and the implementation of the Kuali Financial System (KFS) there was not a single point of entry for purchase requests and an end user could not follow the trail of a purchase request. Since 2009, KFS has helped alleviate some of the workflow issues but there are still many processes that are performed behind the scenes that are never seen within an information system. In addition, there are separate processes that occur in different information systems which are redundant. Often times, the redundant activities are skipped in KFS and only the official systems are updated. This situation leaves the

end user with inaccurate or incomplete information. The essence of the problem studied revolves around transparency, efficiency, timeliness, and cost effectiveness.

C. RESEARCH OBJECTIVES

The primary objective of this research is to re-engineer current business processes for micro-purchasing to be more effective, efficient, and transparent. The ultimate goal is to decrease the amount of time that it takes to complete the processes within the workflow system and improve the turn-around-time it takes that an end user waits to receive a product or service to satisfy a requirement. A secondary objective is to model current processes using an appropriate BPR tool for analysis and improvement. These objectives will be defined, measured, analyzed, improved upon, and controlled based on the KFS workflow and the systems that interact with KFS. The processes will be re-engineered to align the information systems with the stakeholders to result in a more efficient workflow that maintains integrity and transparency while meeting the mission of the school.

D. RESEARCH QUESTIONS

There is a single primary research question which is the focus of this project. This primary research question specifically addresses the Naval Postgraduate School's micro-purchase processes, which may be used as a foundation towards further research to continue to broaden the improvements made in this study, and may also be used as a foundation for other government agencies. There are three secondary research questions which support the primary question.

1. Primary Research Question

Can business process re-engineering techniques be used to improve micro purchase processes at the Naval Postgraduate School and hence the government procurement processes?

2. Secondary Research Question

a. What is the current state-of-the-art methodology and tool for BPR?
b. What is the "as is" process model and system for government/NPS micro-purchases?
c. Which BPR methodologies and tools are best suited to optimize the current process model and system for micro-purchases at NPS?

E. PURPOSE/BENEFIT

The Naval Postgraduate School implemented a workflow and information system in 2009 called Kuali Financial System (KFS). This system has undergone many revisions and updates over the years in an attempt to improve the efficiency, effectiveness, and transparency of the financial systems and procurement processes. However, there are still

many areas for improvement, specifically within the procurement of micro-purchases. The purpose of this research is to further advance improvements in the workflow and efficiencies within information systems at the Naval Postgraduate School.

The intended benefit of this research is to uncover the inefficiencies, offer recommendations for improvement, benefiting the Naval Postgraduate School, and the Navy as a whole. The ultimate goal is to expand the foundation of this research so that it can be applied to a broader scope of problems and systematically improve DOD processes. The methodology, foundation, and developed model can be applied to meet problems faced within the DOD to meet mission objectives per agency and provide a consistent framework.

F. SCOPE/METHODOLOGY

The scope of this project is to address micro-purchases as defined by the FAR. These purchases are under $3,000 and are routine requisitions, not of an urgent nature. The types of requisitions that are included do not include items that require special procedures such as IT equipment that require separate approvals, labor support services, claims for reimbursement, fleet card expenses, conference fees, etc. Furthermore, the scope of this project is aimed at a single department that processes approximately 10 purchase requests per day. The scope of data collected is based on days and a requisition can be submitted within an eight-hour duration over seven days. Limiting the scope of requisitions to a single department is a representative sample since stakeholders are generally all within the same department. Conversely, items that have been approved through the workflow system, ordered, and delivered but returned, exchanged, or damaged are not included in this project since these follow additional processes beyond the scope of this research.

Interviews of each stakeholder were conducted to gather the data to define each process in the workflow. These interviews provided detailed descriptions of the activities involved and a thorough understanding of the work involved in processing a purchase request from initiation to completion. The data gathered from the interviews is the basis for building the models. In turn, the models were developed using a business process management tool.

G. THESIS STATEMENT

While business process re-engineering techniques can be used to improve processes, the focus of this research is to show working models of improved cost, turn-around-time, and performance rather than focusing on software available, features, or benefits of software. The current processes at NPS have undergone continuous improvement over the last five years, however, much more can be done if the time is taken to describe in detail all the processes, including those performed within an information system and those performed by individual stakeholders outside of

information systems. Actions can be performed quickly with the aid of computer systems yet many actions to complete a purchase request are still performed manually and consume a significant portion of the work hours.

THIS PAGE INTENTIONALLY LEFT BLANK

II. LITERATURE REVIEW

Many approaches and methodologies are available for business process re-engineering. This chapter introduces some well-known techniques as well as specific software tools that are used to exemplify the benefits of business process re-engineering. This provides a solid foundation to model the current "as is" Naval Postgraduate School model of micro-purchasing.

A. BACKGROUND

Business Process Re-engineering (BPR) is a philosophy of analyzing the essential, or value adding processes within a business, from defined boundaries that strive to make radical changes in order to improve process performance (El Sawy, 2001). Early methodologies of BPR include Just-in-Time (JIT) and Total Quality Management (TQM) techniques that are designed to make continual improvements to an organizations' ability to provide high quality products, as demanded by the market, with as little waste as possible to the company. A third development within BPR is the Lean Six Sigma approach. This approach marries the ideas of reducing waste in processes while also improving quality within a standard deviation of Sigma Six.

The earlier techniques of JIT and TQM were brought on during the 1980s when Japan had gained market share and the United Kingdom and Unites States were suffering economically. In 1984, the United States Navy requested researchers and consultants to assess the feasibility of using Statistical Process Control (SPC) and quality management methods and recommend improvements for operational effectiveness. This research was based on the teachings of W. Edwards Deming. The first case study directed by Naval Air Systems Command (NAVAIR) at North Island Naval Aviation Depot demonstrated successful improvement in quality. In 1985, the DON coined the term, "Total Quality Management" (Houston & Dockstader, 1997).

B. BUSINESS PROCESS RE-ENGINEERING PHILOSOPHIES

Dating back to the Great Depression, industry has been seeking to improve efficiencies, reduce waste, and ultimately, increase profits. The three major philosophies that have evolved over time are the Just-in-time philosophy, total quality management, and Lean Six Sigma.

1. Just-in-Time Philosophy

Just-in-time (JIT) has been attributed to Taiichi Ohno, a Chinese business man who became an executive for the Toyota Production System. Ohno, started at Toyota Spinning in 1932 during the Great Depression and later transitioned into the Toyota Motor Company in 1943 after World War II ("Taiichi Ohno," 2014). Toyota has included in its vision and philosophy a description of the just-in-time philosophy which explains,

“”Just-in-Time” means making “only what is needed, when it is needed, and in the amount needed” (“Just-in-Time,” n.d.). The goal of this philosophy, when implemented, is to reduce waste, or “muda,” as much as possible. If excess inventory is stored, this is considered waste as it has no value to the customer. Toyota calls this method the “kanban system,” which is representative of the “supermarket method.” Toyota illustrates the JIT operational flow of production as follows in Figure 1.

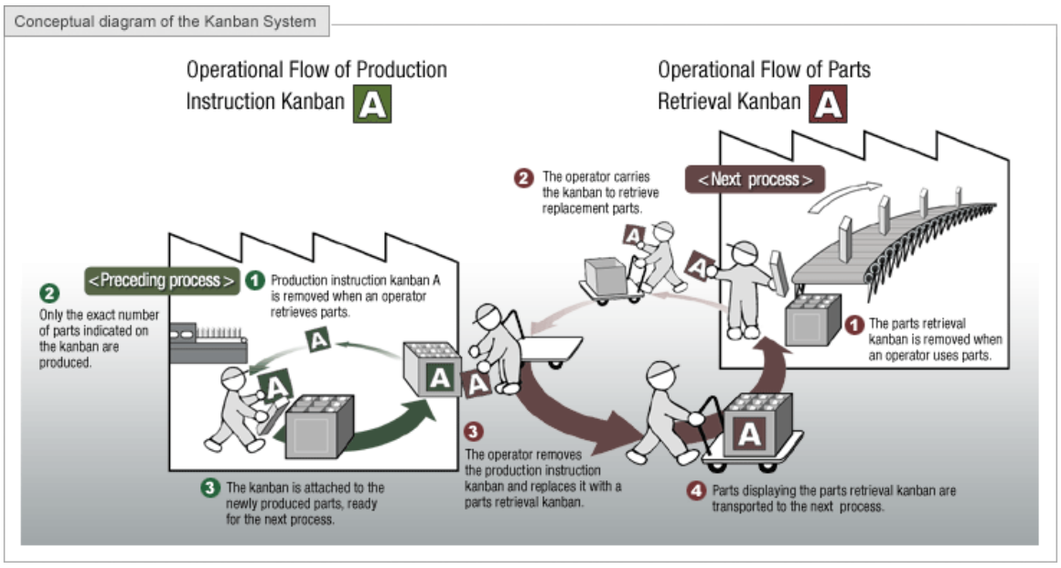


Figure 1. Conceptual Diagram of the Kanban System
(from “Just-in-Time,” n.d.)

One of the biggest benefits of utilizing the JIT methodology is that goods/parts are delivered more frequently to the location where they will be used and thus reduces inventory and warehouse storage costs. This in turn, also reduces obsolescense of products while they wait to be used or become obsolete due to evolving technology (Finkler, Ward, & Baker, 2007). These cost savings can improve an organizations’ competetive advantage. Other advantages to JIT include an organizations’ ability to be agile and respond to demand as environmental changes occur and reduce delay time in processing customer requests (Rolstadas & Andersen, 2000).

While there are many benefits to implementing the JIT methodology, there is also a major weakness to this approach. The JIT philosophy focuses on production and has little emphasis on quality. Therefore, while production speeds may increase with improved processes, there are few, if any, controls or measurements for quality. This can ultimately lead to customer dissatisfaction and a loss of market share and profitability.

2. Total Quality Management Philosophy

As a result of the quality control weakness of the JIT theory, total quality management (TQM) was developed. As previously mentioned, TQM came about most prominently in the 1980s when Japan dominated market share by re-thinking and re-engineering production to improve quality. The early pioneers of TQM included Philip B.

Crosby, W. Edwards Deming, and Joseph M. Juran. They each had their own definition of TQM, but among these three experts, they agreed, "that it is management's responsibility to estabish an organizational culture in which commitment to quality is the main focus" (Suarez, 1992). To define TQM, one must define quality, the totality of the system, and management and the team members involved in the processes. The combined definitions of these three elements, as defined by the organization, create the concept of TQM. The DON also recognized that TQM must first start with the leadership. Therefore, the DON further defined Total Quality Leadership (TQL) as, "the applications of quantitative methods and the knowledge of people to assess and improve all significant processes within the organization now, and in the future" (Houston & Dockstader, 1997). The DON also adapted the Deming chain reaction in order to meet national defense objectives as shown in Figure 2:

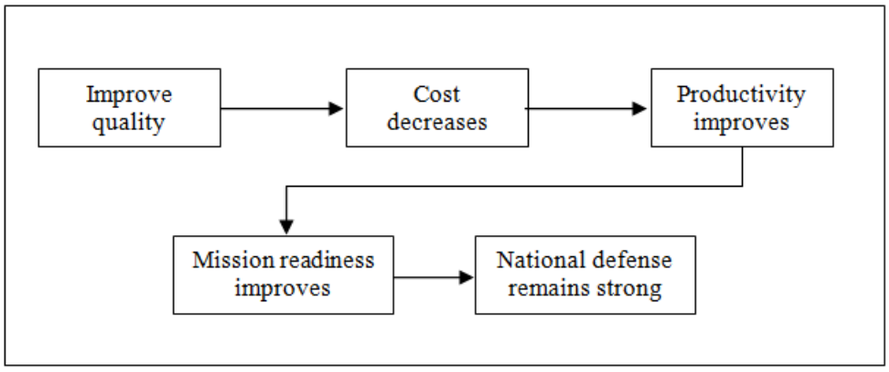


Figure 2. The Chain Reaction in the DON
(from Houston & Dockstader, 1997, p. 25).

The benefits of TQM are much like the benefits of JIT, with the addition of a customer satisfaction element. As customer satisfaction increases, typically market share and profitability increase as well. In the report, *Total Quality Management: A Guide to Implementation*, it states that the benefits of implementing a TQM initiative are achieved by satisfying the following six criteria:

- Exceeding customers' requirements and expectations and being a high quality supplier;
- Believing in people, working to eliminate barriers that prevent people from taking joy and pride in their work, and invovling everyone;
- Tapping the power of individuals, multiplying that power through training and teamwork, focusing that power on understanding and process improvement;
- Recognizing that most problems are in your systems and are not due to particular individuals or circumstances, and providing leadership to continuously improve the systems;
- Making decisions based on data rather than on opinions or emotions; stimulating creating thinking; and seeking innovation in products, processes, and services;
- Focusing more on defect prevention than on defect detection (Mansir & Schacht, 1989).

However, even with these added benefits, it can still be difficult to meet the high quality standards of an ever changing market. Market changes may occur due to rapidly evolving technology or the customers may change. Furthermore, a combination of technology and customers changing may result in a change in the needs of the customer. To make matters more complex, changes in leadership can further delay the successful implementation of TQM. To meet the above criteria to satisfy a TQM initiative, extensive training is required for every employee. This can be difficult to achieve in an environment of 'do more with less.' While the people doing the jobs are overhwhelmed with processes, it can be difficult to obtain buy-in and convince workers that the initial disruption and reduction of productivity to their work to learn and implement new processes is beneficial in the long run. Depending on the skill level of management in communicating the benefits of adopting TQM, employees may be resistent and view the initiative as a way to downsize, which may cause fearfulness and lower morale in the organization.

In the case study undertaken by NAVAIR, the following findings were revealed:

- there was little guidance provided for process definition,
- there was little organic "profound knowledge,"[1]
- management needed to address work prioritization so that employees could engage in the TQM initiative,
- the education and training provided was insufficient, and
- the emphasis on immediate results caused stress and detracted from the goals of the TQM.

3. Lean Six Sigma Philosophy

The very nature of BPR is to continualy improve. Thus, as the broad area of BPR has evolved, many different methods and techniques have been proposed. In addition to the early versions of JIT and TQM, the concept of Lean Manufacturing and Six Sigma arose to meet the continuing demands of increased productivity, eliminating waste, improving efficiency, improving customer satisfaction, and ultimately, increasing profits. More recently, the technique of Lean Six Sigma (LSS) has been widely recognized. There are two parts to defining Lean Six Sigma: a) it is "an improvement method because it uses data to identify and eliminate process problems," and b) it is "an improvement

[1] According to the W. Edwards Deming Institute,

> The System of Profound Knowledge (SoPK) is the culmination of Dr. W. Edwards Deming's lifelong work. It is an effective theory of management that provides a framework of thought and action for any leader wishing to transform and create a thriving organization, with the aim for everybody to win. By management appropriately applying the principles and practices of SoPK, a business can simultaneously reduce costs through reducing waste, rework, staff attrition and litigation, while increasing quality, customer loyalty, worker satisfaction and, ultimately, profitability.
>
> SoPK ties together Dr. Deming's seminal theories and teachings on quality, management and leadership into four interrelated areas: appreciation for a system, knowledge of variation, theory of knowledge and psychology. (The System of Profound Knowledge, 2014)

engine because it establishes a whole new set of roles and procedures inside an organization that work to continuously generate results" (George, Rowlands, & Kastle, 2004).

There are many benefits to implementing an LSS effort which include increasing profitability, developing new job skills, and improving the workplace for employees. Much like the other techniques, the greatest downside to undertaking a LSS effort is the amount of time it may take to train employees. However, despite the investment of time and the uncertainty of success or long term benefits, the skills acquired and the change in mentality towards problem solving is permanent and can be utilized far into the future (George et al., 2004).

The four keys to success that are at the foundation of implementing Lean Six Sigma are to: 1) delight customers with speed and quality, 2) improve processes, 3) work together for maximum gain, 4) base decisions on data and facts (George et al., 2004). These keys are depicted in Figure 3.

Figure 3. Keys to Lean Six Sigma (from George et al., 2004, p. 10)

The LSS approach not only improves business processes by outlining each step, but also uses various statistical models to collect data and remove waste, or unnecessary steps based on actual data. The method for making improvements follows the pattern of defining the problem, measuring the problem, analyzing the problem, improving the problem, and finally controlling the problem. This method is commonly referred to as defing, measure, analyze, improve, control (DMAIC). To define the problem, a team determines what is within scope and what targets the team will aim to reach. For example, the team may determine that costs will be reduced by 10 percent, or customer service satisfaction ratings will improve to 96 percent. Measuring the problem involves obtaining a thorough understanding of the problem and collecting data that can be

measured so that any underlying issues will be exposed. Analyzing the problem pinpoints the exact inputs and outputs to a process or workflow and correlating the data points to the goals of the project. To improve the problem, a test case with proposed solutions is evaluated and pending the results, the solutions can be implemented on a full scale production. The results are compared to the baseline "as is" process and the "to be" process is improved upon in conjunction with the goals. In the control phase of the project, the process is handed off to the process owners along with documentation that includes before and after metrics, training materials, feedback, process maps, a system to monitor the new "to be" model, lessons learned, and recommendations for further improvements (George, Rowlands, Price, & Maxy, 2005).

Since LSS is a continual process that is often applied to complex processes, several iterations of improvements are usually necessary in order to reach the ultimate goal of obtaining a normal distribution within six sigma of deviation. To reach these goals, support from leadership and a long term commitment to the strategic goals of the organization is required.

C. SUMMARY

Among the most popular methodologies over the last 30–40 years, each philosophy has built upon the weaknesses of the previous philosophy. Weaknesses in a philosophy can be defined as whether or not the philosophy meets the needs, or demands, of the customer or market place. The JIT philosophy mainly focuses production and reducing inventory and does not have an element of quality to meet customer requirements. TQM attempts to address quality standards in addition to the needs of production and reducing wasteful inventory. Finally, after the concepts of Lean Manufacturing and Six Sigma were introduced, the philosophy of Lean Six Sigma married the ideas of customer satisfaction with process workflows by addressing quality, speed, variation and defects, and process flow.

This research focuses on implementing a Lean Six Sigma approach to improving efficiency and reducing wait time for the end user. The Lean Six Sigma approach is ideal for analyzing the essential, or value adding processes from defined boundaries. To achieve quality within a standard deviation of sigma six, iterative and continual improvements in processes are necessary.

III. BUSINESS PROCESS MODELING SOFTWARE

A. OVERVIEW

According to the Savvion Business Process Management (BPM) software "allows businesses to easily and quickly adopt BPM as a core discipline" ("Gear Up: How to Model in 20 Minutes," n.d.). The software allows a business to articulate ideas, simulate reality, and document the process ("Gear Up: How to Model in 20 Minutes," n.d.). In addition to being able to visualize the business processes, the software allows an organization to see processes working within existing IT architectures. The ability to see how processes are interconnected and interdependent allows decision makers to make changes within the business process model to improve efficiency and accuracy.

In a case study, TransUnion utilized the Savvion process-optimization platform and used the Business Manager tool to allow individual units to automate processes. A cornerstone to the TransUnion business strategy is to focus on process-quality enhancements. By empowering managers to use the information technology (IT) resources, the individual components of the company benefit as well as the corporation (Lombardo, Leaver, & Walker, 2003).

Nissho Electronics Corporation also recognized the benefits of the Savvion BPM software and integrated it into its' existing debt management application. Similar to TransUnion, Nissho Electronics empowered management, to include remote units, to define and document their processes. By combining the Savvion BPM Suite with Nissho's existing professional suite, the corporation can quickly respond to changes in the environment, including changes in management, laws, or regulations (Nisho Electronics).

B. MAIN FEATURES

The Savvion tool is easy to use for any person, whether they are an IT professional or a business analyst. The graphical user interface (GUI) provides basic layouts with drag-and-drop capabilities and allows the user of the software to see processes in a graphical design. Although it has an easy to use interface, it still provides robust functionality that "runs as Enterprise JavaBeans (EJBs) on WebSphere or WebLogic application servers, leveraging J2EE integration standards such as Java Connector Architecture (JCA) and Java Messaging Service (JMS), and it is architected for high-volume scalability and enterprise-class "nonstop" operation" (Silver, 2007). Savvion provides the user with color coded swim lanes to define each stakeholder. Each swim lane is defined by certain characteristics such as whether or not the stakeholder is an individual or a group of people, the length of time to complete a task, and the criticality of a task (high, medium, or low). Probability can also be assigned to decisions so that as the model runs the defined amount of occurrences, statistics can be generated to

show bottlenecks by looking at the length of time and probability of occurrence of tasks. Other features that are included in the Savvion software include the ability to define parallel tasks governed by logical decision points such as "AND," "OR," or "XOR."

In addition to its ease of use and providing quick deployability, the Naval Postgraduate School also maintains an education license which allows students free access to the software to produce high quality models that demonstrate business processes.

C. NPS MICRO PURCHASING MODEL

> The Naval Postgraduate's School's official mission statement is as follows:
>
> The mission of the Naval Postgraduate School is to provide relevant and unique advanced education and research programs to increase the combat effectiveness of commissioned officers of the Naval Service to enhance the security of the United States. In support of the foregoing, and to sustain academic excellence, foster and encourage a program of relevant and meritorious research which both supports the needs of Navy and Department of Defense while building the intellectual capital of Naval Postgraduate School faculty. ("About NPS," 2014)

1. The Goal

In order accomplish the mission of NPS, procurements are a necessary requirement. Textbooks, printer paper, printer cartridges, lab equipment, etc. may seem like small and insignificant purchases, but it is these very basic necessities which provide the foundation to excellence in teaching and research and support the needs of the Navy and DOD. In order to procure something as simple as a ream of paper, a strategic workflow is required in order to provide a relevant and meritorious level of education and research capability for the community. The various regulations provide the basic procedures for simplified acquisitions. In addition to the overarching regulations, each agency must determine its' own strategy in order to meet its' mission need.

The current workflow system used at NPS is Kuali Financial System version 3.0 which is a suite of financial software designed to meet the needs of colleges, universities, and other organizations that desire an open, modular, and distributed system ("Overview of KFS," n.d.). There are many universities that use KFS such as Indiana University, several of the Universities of California, Cornell University, and Stevens Institute of Technology ("Adopters," n.d.).

The KFS provides purchasing and accounts payable modules which allow end users to submit requests for goods/services which becomes a purchase order by utilizing a set of rules that "moves" the request from one stakeholder to the next until the original end user receives his/her item. Determining an overarching strategy to accomplish the mission of the school can be implemented directly through an information system such as

KFS and can also be continuously improved upon via a Lean Six Sigma approach to streamline acquisition procedures that meet the unique requirements of NPS.

D. SUMMARY

In this chapter, we have discussed several well-known tools for business process re-engineering. The tools discussed have presented various features and capabilities for the applicability of this research. It is important to embrace the idea that processes ought to be driven by the requirements of the organization and not driven by information systems that cannot be adapted quickly, easily and integrated with other information systems. Ideally, information systems support the business processes in an efficient and effective manner. Therefore, information systems require modularity and a deployment and maintenance schedule that forecasts needs into the future so that they do not become antiquated as processes continue to improve.

THIS PAGE INTENTIONALLY LEFT BLANK

IV. DATA AND ANALYSIS

A. THE "AS IS" MODEL

The current model for submitting and processing a purchase request starts with the end user identifying a need. The need to purchase an item is driven by the requirements of a project or research activity. Once the end user has verified that an item needs to be purchased, market research is conducted. A purchase request is initiated by the end user and submitted electronically into KFS. The funding is also identified and the end user initiates a funding document in the financial system FastData (FD).

Next, the sponsored program financial analyst (SPFA) receives an automatically generated notice that a purchase request has been submitted and needs review. This is the first point in the model where a purchase request can be approved or disapproved. If the purchase request is approved, the SPFA makes an entry into another financial system called Memorandum Accounting System (MAS). The SPFA then logs into FD and moves the funding document from being in an "initiated" status into a "sourced" status. The funding document is then saved as a PDF and uploaded into KFS. The PDF of the funding document provides the purchase card holder (PCH) with the authority to make the purchase. After the funding document has been sourced and the MAS entry is made, the purchase request is approved in KFS. Based on a set of rules defined in KFS, the purchase request is electronically sent to the Authorizing Official (AO) for further processing. If the purchase request is disapproved, the SPFA will cancel the funding document in FD, disapprove the KFS requisition, and notify the end user.

When the AO receives a notice from KFS, the purchase request is reviewed. The focus of the AO review is to check for completeness and accuracy of the information provided. This is a second point in the workflow where a purchase request can be approved or disapproved. If the purchase request is approved, a notice is sent to the supervisor for all PCH's. The request is assigned to a PCH and it becomes a purchase order.

Finally, the PCH receives a notice automatically generated from KFS. The PCH opens the purchase order and reviews it. This review can result in an approval or disapproval. If this purchase order is approved, the PCH identifies a vendor if one is not already provided and determines the cost and obtains any necessary additional funding. In addition to the work contained in KFS, many PCH's maintain their own electronic records to keep track of their work. The PCH also must create a hard copy of the purchase order for auditing and recordkeeping purposes. Once the file(s) are created, the vendor is identified, and funding is obtained, the PCH can place the order with the vendor. The vendor ships the item to a central location and the PCH contacts the end user to arrange for a pick-up of the item. If an invoice is included with the packing of the item, the PCH will have the end user sign the invoice. The PCH updates KFS with notes and

the final cost and places the signed hard copy invoice in the hard copy file. If the invoice is not included in the packing with the item, the PCH must contact the vendor to obtain the invoice and make further arrangements with the end user to sign it and complete the purchase order activities.

A brief synopsis of activities per swim lane is depicted in Table 1.

Table 1. "As Is" Swim Lane Activities

END USER (EU) • Identifies a need to purchase an item • Submits the purchase request o Enters the request in KFS o Enters the request in FastData (FD) • Picks up item
SPONSORED PROGRAM FINANCIAL ANALYST (SPFA) • Reviews original purchase request submission to ensure there are sufficient and valid funds and that the item falls within the scope of the identified funding. • If the purchase request falls within the funding scope of the purpose, time, and amount, the requisition is approved. o Various information systems are updated and a hard copy file is created and stored. o If the purchase card holder needs additional funding to procure the item, the SPFA provides the additional documentation and updates the systems. • If the SPFA has questions, the end user will be contacted to provide additional information. Once the additional information is received, the SPFA will re-review the purchase request. If there are any issues that cannot be resolved, the purchase request is disapproved.
APPROVING OFFICIAL (AO) • Reviews purchase request for approval or disapproval. • If approved, the purchase request is assigned to a Purchase Card Holder. • If there are issues that cannot be resolved, the purchase request is disapproved.
PURCHASE CARD HOLDER (PCH) • Reviews purchase order for all required documentation. • If approved, several activities occur to include: o Create a hard copy of the purchase order and store it, o Create/maintain an electronic log of the purchase order for tracking purposes, o Identify a vendor from which to purchase the item. o If the cost of the item is greater than the anticipated cost of the purchase request, the PCH contacts the SPFA for additional funding. Once the additional funding is received, the purchase order is placed with the vendor. o Once the item is delivered, the PCH contacts the EU for pick up. o If the invoice is included in the packaging of the item, the end user signs the invoice and the PCH updates the electronic file, hard copy file, and the information systems. o If the invoice is not included in the packaging, the PCH will contact the vendor to obtain the invoice and the end

user will either return to the PCH to provide a physical signature or the invoice can be e-mailed to the end user to sign and return. The purchase order cannot be closed until the signature of the end user is obtained and placed in the hard copy file of the purchase order.
    - If the end user does not accept the item for final delivery, the item is returned to the PCH. A new set of workflow activities would commence in the event of a rejection of the item.
- If the purchase order has issues that cannot be resolved, the purchase order is disapproved.

1. Modeling the "As Is" Model Using a Process Modeler

The Savvion model (Figure 4) shows the current "as is" process starting with the end user identifying a need until the purchase order is complete. Each activity has an average time to complete and an average associated cost.[2] As depicted in Figure 4, there are four basic swim lanes. Each swim lane represents a stakeholder in the purchasing process. Within each swim lane, each stakeholder performs tasks, which at times, are inter-dependent on the tasks of another stakeholder.

[2] The times and costs were based on subject interviews and average Government Service (GS) levels that are typically hired to perform each function. These averages are based on the personnel at the Naval Postgraduate School and include the locality adjustment.

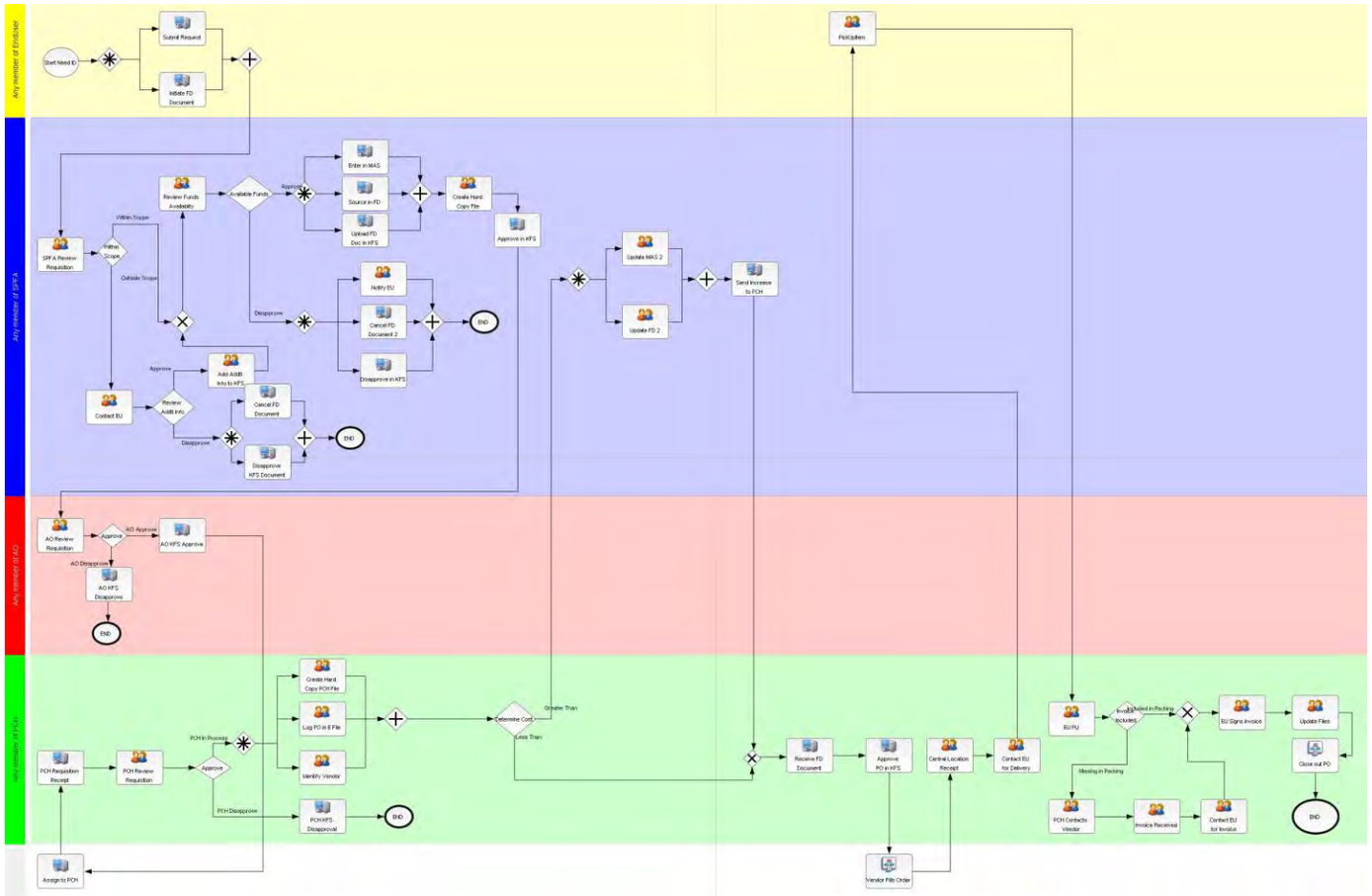


Figure 4. “As Is” NPS Purchasing Model as Modeled in Savvion Process Modeler

Albeit the diagram has been simplified for purposes of page size limitations, the complexity of the procurement process and several potential points of failure are clearly evident. To summarize, the stakeholders required to complete the activities associated with a purchase request include the end user, SPFA, AO, the supervisor of all PCH's, and the PCH. The information systems involved include KFS, FD, MAS, and any personal electronic files used by any stakeholder along the way. The stakeholders involved and the information systems used are the foundation of the simulation of the micro purchasing model at NPS.

2. Analysis of the "As Is" Model

The ultimate goal is for the end user to receive the item to satisfy the identified need. The end user is representative of any department, institute, or group and is dependent on several functional areas for the successful completion of a purchase order. The successful completion of a purchase order relies on three information systems, namely, KFS, FD, and MAS. These three systems are stand-alone systems and are not interoperable. The official Navy financial system is FD; however, NPS has instituted KFS and MAS in an attempt to fill the gaps of transparency and information sharing.

In the current model, all three systems are mandatory and the activities associated with keeping them up to date cause bottlenecks resulting in delays in performing the next task or alternatively, the information systems are not updated in a timely manner. In the case of the latter situation, an out-of-date system causes further delays in the future when additional needs are required. These delays can most significantly impact the end user, the SPFA, or the PCH. The end user may experience a delay if the balance of funding is inaccurate in one or more of the systems; the SPFA may experience delays if the systems must be updated in batches vice being updated as changes occur thus, the time spent updating the systems stalls any new work coming in; or the PCH may experience delays if the information systems are not updated with final costs and similar to the SPFA, the PCH must perform batch updates preventing the PCH from performing any new work. In turn, if the PCH does not update the systems with final costs, the SPFA must either contact the PCH for costs or the SPFA is forced to work in an unknown environment of

how much funding is actually available. There is a two-fold impact of having inaccurate accounting systems: a) morale lowers among stakeholders if there is not reasonable assurance in the information systems, further impacting the needs of the end user being met, and b) any given stakeholder resorts to maintaining manual files which causes 'islands of information', discrepancies in information, and a redundancy of activities.

Aside from the information systems in use and the complexity of the procurement process, the potential failure points can be reduced to two types of errors. Each error is attributable to problems internal rather than external to the workflow system. Type One errors can be thought of as "complete" or "catastrophic" errors. In a Type One error, the workflow fails decisively, at one or more points in the process, resulting in a larger failure to achieve the ultimate goal of the end user receiving the item to satisfy a need. If a Type One error occurs, it is considered mission failure.

Type Two errors can be thought of as 'efficiency errors'. In this context, efficiency may be defined simply as the end user receiving the item within the constraints of cost and schedule. The inability to receive the item while managing competing resources of time or deadlines and available funding results in a Type Two error. Considering the principle that "time is money," the time it takes to accomplish a task and the cost of doing business tends to be directly related either because, for any cost per unit of time, an increase in the time it takes to get the job done means an increase in cost, or because achieving the deadline requires committing more manpower (and/or other resources) than would be required in a comparable system operating at a higher level of efficiency. Inefficient systems, in short, tend to be less time effective and less cost effective than their more efficient counterparts. In the case of the purchase process workflow system, this simply means that the acquisition process takes longer and costs more than it would if internal operating processes were streamlined. Efficiency errors can effectively become catastrophic errors if the process is so slow that critical deadlines are missed ultimately resulting in mission failure.

The Type One error is a discrete error in that it either occurs or it does not occur. Simply stated, the purchase request or purchase order is either approved or disapproved. The reason for disapproval may vary, but the danger is that at every critical functional

area there is a risk of failure. By contrast, Type Two errors occur to a matter of degree. As a practical matter, all complex systems are more or less efficient. The principle concern is not that any particular functional area in the workflow system is operating less efficiently than it might, but there are many points in the system where efficiencies might be improved to benefit the workflow system and mission as a whole. Efficiency errors, in this sense, compound and accumulate within the workflow system. Even a small inefficiency contained anywhere within a complex system can lead to significant increases in time and cost.

In the case of the NPS purchase process workflow system, the main issue is not that of Type One errors but rather Type Two errors. This is noteworthy considering the complexity of the process as illustrated in Figure 3. At each functional area, there is at least one chance that a purchase request may be disapproved. Once the end user completes the market research, determines that a need exists and submits the requisition, the entire process could stop if it were to be disapproved by the SPFA. It could be disapproved at this level if the SPFA determines that the request does not fall within the scope of the type of funding identified, if the funding is set to expire before the PCH can order the goods/services, or if there is or appears to have insufficient funding. Even after additional information is received from the end user, disapproval is still uncertain. Additionally, if there are questions at the AO or PCH stages, disapproval can still occur. With these many points of potential failure, and the fact that a requisition cannot move to the next stage without prior approval, each step in the process is crucial. Even a small probability of failure can produce mission failure results that are unacceptable.

Fortunately, the human elements prevent catastrophic, Type One errors. The stakeholders in each functional area intervene for success, they don't impede success. However, structural problems, that is, the strategy of the current model prevents successful completion of procurements. It is not the stakeholders working within the system that cause the failure, but rather the implementation of the strategy that causes the inefficiencies within which everyone has to work. While documenting the current model and interviewing each stakeholder, the most common words used to describe whether a requisition would be approved or disapproved were common sense, good judgment,

investigating/researching discrepancies, and relying on memory based on prior experiences.

While cost and schedule requirements may be value drivers for the end user, improving performance or efficiency can markedly improve the system as a whole. Reducing or eliminating the tasks performed outside of an information system and/or redundant activities will improve the cycle time of the overall process. The net benefit will be a cost savings with an ancillary benefit of improving morale and confidence in the system.

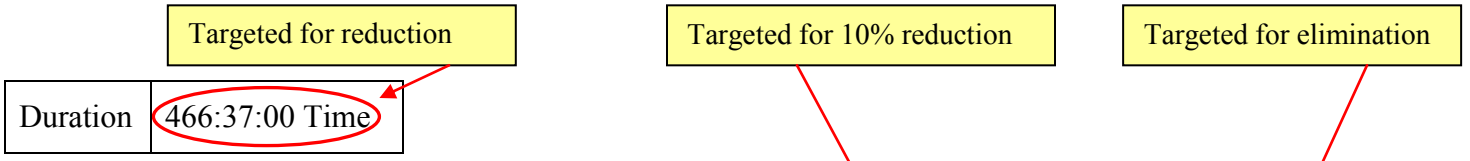
3. Simulation Results of the "As Is" Model

The model generated by the Savvion software provides a structured method with which to analyze the processes, identify the bottlenecks, reduce or eliminate waste, and provide a solution to achieving the most efficient model for the purchasing workflow. The current process shows bottlenecks/wait times during three of the swim lanes, or functional areas as well as the associated cost for completing a total of 10 purchase orders.

A bottleneck occurs at the very beginning of the workflow when the end user initiates the funding document in FD. The time it takes for an end user to access the FD system and initiate the funding document immediately slows down the process. A second bottleneck occurs with the SPFA when the funding document is sourced in FD and uploaded into KFS as a PDF. Alternatively, if the SPFA disapproves a requisition, a bottleneck occurs while canceling the funding document. When the purchase order is approved by the PCH, a third bottleneck occurs while identifying the vendor, maintaining personal electronic records, and creating a hard copy file of the purchase order. Finally, the last bottleneck identified was with the PCH closing out the purchase order and updating the purchase order records. The total work time for all activities took 1,759 hours and four minutes (1759:04:00), a total wait time (bottlenecks) of one hour, 46 minutes, and 15 seconds, and a total cost of $358.35

Table 2 highlights the issues identified in the Savvion model.

Table 2. Savvion "As Is" Metrics



Duration	466:37:00 Time

Process	Scenario	Instance	Total Cost ($)	Waiting Time (Time)	Total Time (Time)
ProcurementProcess	(Default)	10	358.35	1:46:15	1759:04:00
		Grand Total	**358.35**	**1:46:15**	**1759:04:00**

Activity	Performer	Occurs	Waiting Time (Time)	Time To Complete (Time)	Total Time (Time)
AO Review Requisition	Any member of AO	9	0:00:00	0:37:45	0:37:45
Add Addtl Info to KFS	Any member of SPFA	1	0:00:00	0:07:15	0:07:15
Central Location Receipt	Any member of PCH	7	0:00:00	1:16:45	1:16:45
Contact EU	Any member of SPFA	1	0:00:00	0:06:00	0:06:00
Contact EU for Delivery	Any member of PCH	7	0:00:00	0:30:45	0:30:45
Contact EU for Invoice	Any member of PCH	3	0:00:00	0:13:45	0:13:45
Create Hard Copy File	Any member of SPFA	9	0:00:00	0:27:30	0:27:30
Create Hard Copy PCH File	Any member of PCH	7	0:00:00	1:51:45	1:51:45
EU PU	Any member of PCH	7	0:00:00	0:37:45	0:37:45
EU Signs Invoice	Any member of PCH	7	0:00:00	0:37:45	0:37:45
Identify Vendor	Any member of PCH	7	0:00:00	1:58:45	1:58:45
Invoice Received	Any member of PCH	3	0:00:00	0:03:00	0:03:00
Log PO in E File	Any member of PCH	7	0:00:00	0:23:45	0:23:45
Notify EU	Any member of SPFA	1	0:00:00	0:03:00	0:03:00
PCH Contacts Vendor	Any member of PCH	3	0:00:00	0:16:00	0:16:00
PCH Review Requisition	Any member of PCH	8	0:00:00	0:33:30	0:33:30

Activity	Performer	Occurs	Waiting Time (Time)	Time To Complete (Time)	Total Time (Time)
PickUpItem	Any member of EndUser	7	0:00:00	0:35:00	0:35:00
Review Funds Availabiity	Any member of SPFA	10	0:00:00	1:44:15	1:44:15
SPFA Review Requisition	Any member of SPFA	10	0:00:00	0:11:15	0:11:15
Update FD 2	Any member of SPFA	2	0:00:00	0:08:00	0:08:00
Update Files	Any member of PCH	7	0:00:00	1:58:45	1:58:45
Update MAS 2	Any member of SPFA	2	0:00:00	0:08:00	0:08:00
AO KFS Approve	Generic	8	0:00:00	0:04:15	0:04:15
AO KFS Disapprove	Generic	1	0:00:00	0:00:45	0:00:45
Approve PO in KFS	Generic	7	0:00:00	0:07:45	0:07:45
Approve in KFS	Generic	9	0:00:00	0:09:30	0:09:30
Assign to PCH	Generic	8	0:00:00	1:28:30	1:28:30
Cancel FD Document	Simulation Results	0	0:00:00	0:00:00	0:00:00
Cancel FD Document 2	Generic	1	0:00:00	0:02:30	0:02:30
Disapprove KFS Document	Simulation Results	0	0:00:00	0:00:00	0:00:00
Disapprove in KFS	Generic	1	**0:02:30**	0:01:30	0:04:00
Enter in MAS	Generic	9	0:00:00	0:27:30	0:27:30
Initiate FD Document	Generic	10	**0:21:15**	0:44:15	1:05:30
PCH KFS Disapproval	Generic	1	0:00:00	0:00:45	0:00:45
PCH Requisition Receipt	Generic	8	0:00:00	0:04:15	0:04:15
Receive FD Document	Generic	7	0:00:00	0:07:45	0:07:45
Send Increase to PCH	Generic	2	0:00:00	0:03:00	0:03:00
Source in FD	Generic	9	**0:27:30**	0:27:30	0:55:00
Submit Request	Generic	10	0:00:00	0:21:15	0:21:15
Upload FD Doc in KFS	Generic	9	**0:55:00**	0:27:30	1:22:30
Close out PO	Generic	7	0:00:00	3:32:15	3:32:15
Vendor Fills Order	Generic	7	0:00:00	1738:39:15	1738:39:15

Of the bottlenecks identified, there are three basic bottlenecks: a) activities associated with FD, b) the beginning stages of creating the purchase order (PO), and c) the end stages of closing out the PO. For the 10 instances of a purchase order, the end user received the item 70 percent of the time. Of the 70 percent of items received, 10 percent were returned or exchanged for various reasons. Thirty percent of the time, the item was disapproved as follows:

- SPFA disapproval 10 percent
- AO disapproval 10 percent
- PCH disapproval 10 percent

Although the model resulted in a possible 30 percent disapproval rate, in reality, this is closer to a 10 percent disapproval rate. The reason for this discrepancy between the model and reality can be attributed to the limitation of the software of only being able to enter probability percentages as a whole number. When the attributes are defined for each process in the Savvion software, the GUI only allows a whole number ranging from zero to 100 to be entered. So while it is desirable to have a 90 percent approval rate within the model, the goal is to improve efficiency and quality, reduce wait time and bottlenecks, and eliminate errors. Typically speaking, if a requisition is disapproved at the AO or PCH level, an error of some sort has usually occurred. A wrong line of accounting has been selected, an item was coded incorrectly in the system, or the required paperwork is not complete in order for an item to be purchased. While these disapproval reasons can be mitigated through proper training and experience, if the efficiency rate improves then the end user will be identified sooner in the process rather than later so that alternative plans can be made to solve this type of error. With respect to the wait times associated with the FD activities, these activities cannot be eliminated, however, they may be improved upon if other activities were shifted or eliminated.

4. Goals of the "To Be" Model

As previously discussed, the objective of this research is to improve the Type Two errors, or "efficiency errors." Based on the simulation results of the "as is" model, the goals for the "to be" model are to:

- Reduce total duration time
- Reduce total cost by one percent
- Drastically reduce or eliminate total wait time

B. THE "TO BE" MODEL

By applying the techniques of LSS, a "to be" model was created. The technique involves defining the problem, measuring, analyzing, improving and controlling. The problem defined was that the processes to complete a purchase request are inefficient, redundant, and do not provide accurate financial data which can impact other decisions utilizing the same line of funding. When data was gathered from the stakeholder interviews, each process was measured to describe how much time it typically takes to complete an activity. The two measures gathered included time and cost which are compared to the baseline "as is" model. The critical inputs in the process were analyzed to pinpoint where improvements can be made. Improvements focus on reducing time, cost and bottlenecks that impede efficient processing. The "to be" model is based on the same stakeholders involved in the process and focuses on a 'cradle to grave' solution. The goals for improvement are based on the data and facts gathered from the "as is" model to improve quality, process time, costs and reduce variations. Reducing variations, or bottlenecks, have a direct correlation to reducing time and cost. Control measures include the models and recommendations for further research to continue improvement in the processes.

The following sample project charter has been developed around the principles of LSS as seen in Table 3.

Table 3. Sample Project Charter

Project Charter

Purchase Request Process Improvement

Description: Improve process time by defining a precise process, managing the process, improving efficiency, and reducing cycle time by at least 10% without increasing total cost.

Background: There have been several changes in work processes at NPS to submit and process a purchase request. The "as is" processes need to be analyzed and developed for a clear understanding of the impact of the recent changes.

In Scope: Micro-purchases under $3,000 of a routine nature.

Out of Scope: All other purchases over the SAP, and micro-purchases that require special processes such as SF182, SF1164, DD1149, DD1144, IT equipment, labor services, fleet card expenses, returns/exchanges/damaged goods.

KPOV: Purchase request wait time and total time to complete.

Goals:

1. Reduce wait time, or bottlenecks within the system by at least 10%.
2. Reduce total cost of the process by at least 10%

Assumptions:

1. Improving efficiency and reducing total time will result in the ability to perform other tasks within the job of each person to a greater extent without increasing cost.
2. Each stakeholder in the process is a full time employee.

Other Benefits:

1. A reduction in errors in the financial systems by limiting access to the financial systems.
2. An improvement in morale among all stakeholders as work is appropriately shifted and end users are alleviated from new responsibilities that are inefficient.

To achieve improvement in processes in the "to be" model, several modifications were made to the workflow processes. The "to be" model for submitting and processing a purchase request remains the same with the trigger of the end user identifying a need. The end user must still perform the same activities of verifying that an item is required and conducting market research. The most significant change for the end user in the "to be"

model is that the end user no longer initiated the funding document in FD. The end user simply submits the purchase request electronically into KFS.

Next, the SPFA receives the automatically generated noticed from KFS that a purchase has been submitted and is ready for review. The SPFA must still review the requisition but within the approval workflow activities, will also initiate the funding document in FD. This additional activity is offset by the removal of maintaining MAS since this financial tool was created by NPS and based on requirements that are no longer relevant and are now redundant with the information systems currently available. Another difference with the SPFA initiating the funding document in FD is that if a requisition is disapproved, then the activity of canceling the funding document in FD no longer exists. This is because the end user never initiated it and it is only initiated if the requisition is approved. Making this change saves additional time for the SPFA in the disapproval workflow activities.

When the AO receives the notice from KFS to review a requisition, the AO now sources the funding document in FD obligating the funds for the PCH to make place the purchase order. Although this is an additional step and it does add wait time to the entire process, making this change removes all other wait times. When the AO approves the requisition it is assigned to a PCH by the supervisor and the PCH is notified of a purchase order that is ready to be reviewed. If the AO disapproves the requisition, the AO would also then cancel the funding document in FD. The SPFA and EU would receive an automatically generated notice of the disapproval in KFS, thereby also notifying the SPFA that the funds were not obligated.

Finally, the PCH receives an automatically generated notice from KFS. The PCH reviews the purchase order as before, but the difference in the "to be" model is that the PCH no longer maintains a separate, individual electronic file of work in progress. If a running list of work in progress is needed for reference, a report can be generated from KFS based on the identification number of the PCH. This removes wasteful activities from the workflow process that do not add value to the end user. Removing this activity also saves time for the PCH so that an additional file is not being maintained and the information contained therein is not out of synch with the workflow activities. Any notes

or comments can be maintained within KFS so that 'islands of information' are removed and avoided.

A brief synopsis of the "to be" model activities per swim lane is depicted in Table 4.

Table 4. "To Be" Swim Lane Activities

END USER (EU) • Identifies a need to purchase an item • Submits the purchase request   ○ Enters the request in KFS • Picks up item

SPONSORED PROGRAM FINANCIAL ANALYST (SPFA)
• Reviews original purchase request submission to ensure there are sufficient and valid funds and that the item falls within the scope of the identified funding.
• If the purchase request falls within the funding scope of the purpose, time, and amount, the requisition is approved.
  ○ The funding document is initiated in FD and a hard copy file is created.
  ○ If the purchase card holder needs additional funding to procure the item, the SPFA provides the additional funding documentation.
• If the SPFA has questions, the end user will be contacted to provide additional information. Once the additional information is received, the SPFA will re-review the purchase request. If there are any issues that cannot be resolved, the purchase request is disapproved.

APPROVING OFFICIAL (AO) • Reviews purchase request for approval or disapproval. • If approved, the funding document is sourced and the purchase request is assigned to a Purchase Card Holder. • If there are issues that cannot be resolved, the purchase request is disapproved and the funding document is canceled.

PURCHASE CARD HOLDER (PCH)

- Reviews purchase order for all required documentation.
- If approved, several activities occur to include:
  - Create a hard copy of the purchase order and store it,
  - Identify a vendor from which to purchase the item.
  - If the cost of the item is greater than the anticipated cost of the purchase request, the PCH contacts the SPFA for additional funding. Once the additional funding is received, the purchase order is placed with the vendor.
  - Once the item is delivered, the PCH contacts the EU for pick up.
  - If the invoice is included in the packaging of the item, the end user signs the invoice and the PCH updates the electronic file, hard copy file, and the information systems.
  - If the invoice is not included in the packaging, the PCH will contact the vendor to obtain the invoice and the end user will either return to the PCH to provide a physical signature or the invoice can be e-mailed to the end user to sign and return. The purchase order cannot be closed until the signature of the end user is obtained and placed in the hard copy file of the purchase order.
  - If the end user does not accept the item for final delivery, the item is returned to the PCH. A new set of workflow activities would commence in the event of a rejection of the item.
- If the purchase order has issues that cannot be resolved, the purchase order is disapproved.

1. Modeling the "To Be" Model Using a Process Modeler

The Savvion model (Figure 6) shows the "to be" process starting with the end user identifying a need until the purchase order is complete. Each activity has an average time to complete which has not changed from the "as is" model. The stakeholders remain the same and the four swim lanes depict the tasks performed. There continues to be the same points of failure for disapproval however, the tasks associated with each

stakeholder has been modified to include interfacing with KFS and FD. Personally maintained electronic files and MAS have been removed from the workflow process.

2. Analysis of the "To Be" Model

The ultimate goal identified was for the end user to receive the item to satisfy the identified need in a more efficient manner, reducing total time and cost. The successful completion of a purchase order now relies on two information systems, namely, KFS and FD. The total time, wait time, and cost was successfully reduced in the "to be" model. Table 5 summarizes the results:

Table 5. Summary of Results

Category	"As Is" Model	"To Be" Model	Delta	Percentage
Duration	466:37:00	249:22:45	217:14:15	~47%
Total Cost	$358.35	$337.50	$20.85	~6%
Wait Time	1:46:15	0:05:00	1:41:15	~97%
Total Time	1759:04:00	734:48:48	1024:55:12	~59%

By re-engineering the activities within the end user, SPFA and AO swim lanes, bottlenecks were dramatically reduced or in some cases, eliminated. Eliminating the bottlenecks allows for a more constant rate of flow with few deviations from a normal distribution. When these bottlenecks are reduced or removed, each stakeholder has the requisite amount of time to complete each activity. By allowing sufficient time to complete activities, this avoids the problem of information systems not being up to date. When the financial systems are accurate, end users can make informed decisions about the burn rates and expenditures of funding and confidence is restored in the systems and workflows. Where there was previously a negative snowball effect of problems associated with inaccurate information systems, stakeholders can now be more efficient

as time is freed up to complete additional activities. This not only improves productivity for the purchase request/order workflow, but it would improve overall productivity per person.

Re-engineering a few activities that were causing bottlenecks improves the total duration from approximately 20.96 days to 10.4 days. When schedules and deadlines are critical, this time gained from beginning to end can mean the success or failure of a requirement. Additionally, with a decrease in the amount of time it takes to complete the workflow, cost savings are realized which can be applied towards other underfunded requirements. Within the political and economic landscape of today, cost savings of any kind is critical.

3. Simulation Results of the "To Be" Model

The structured method by which the processes were re-engineered and modeled within the Savvion process modeler identified the bottlenecks, total time, total time per processes, total duration, and total cost. The simulation results allow for a more efficient model to be constructed that saves both time and money. To maintain consistency from the "as is" model, a total of 10 purchase requests were processed.

The initial bottleneck occurring with the end user initiating the funding document in FD was eliminated when this activity was moved to the SPFA swim lane. There are several benefits to eliminating this bottleneck at the end user. First, the end user is not overwhelmed with the administrative tasks of submitting a purchase request and is able to focus on the core responsibilities of the work being performed. Secondly, removing the bottleneck with the first step of the end user, allows for a more regulated and predictable amount of work flowing down stream. Having a regulated and predictable throughput of work enables others to manage their time and resources better. Also, by removing the bottleneck of the end user interacting with FD, this limits the number of people accessing an official Navy accounting system and provides an avoidance of risk for making errors in FD.

By moving the initiation of the funding document to the SPFA swim lane, this also removes the activity of having to cancel the funding document if the purchase

request is disapproved. The funding document would only be initiated if it was approved. This saves time for the SPFA and avoids redundant tasks of having a funding document initiated only to turn around and cancel it in the case of disapproval. Sourcing the funding document in FD was causing the next bottleneck for the SPFA. The SPFA now initiates the funding document, but only works with FD and KFS in the situation of an approval.

The activities associated with updating the MAS financial system have been eliminated for the SPFA. MAS was built in a MicroSoft Access database to meet unique needs of NPS many years ago. Since KFS has been implemented, many of the functions in MAS are available in KFS and if there are functions of MAS that are still being utilized, KFS can be upgraded to include this functionality based on its' open architecture and modularity. In addition to MAS being outdated, these activities were also removed based on the LSS principles that only value adding activities are kept in a re-engineered process model. Any activities that do not provide value to the customer, in this case, the end user, are considered waste and should be removed. Therefore, on these two fronts, one being that MAS is outdated, and two being that the activities in MAS are non-value adding to the customer, this task has been eliminated. As expenditures occur in KFS from the end user initiating a purchase request, the use of FD for initiating and sourcing the funding documents to the PCH updating KFS with final costs and finally, the SPFA updating FD with the actual amount of a purchase order, the entries in MAS are redundant. KFS and FD both provide reporting features to provide detailed information for financial planning and projecting.

When the SPFA initiates the funding document in FD, this "commits" the funds. In other words, the funds are set aside for the procurement of an item. When the AO receives notification from KFS to review a purchase request, the AO will 'source' the funding document, obligating the funds for use. While sourcing the funds in FD by the AO does generate a bottleneck, the bottleneck is small and the trade-off is that the activity is more closely aligned with the responsibilities of an AO. Further research could be performed to try to remove this small bottleneck but given the time savings in all other areas, the wait time has still been reduced by 97 percent, well within a deviation of six sigma of a normal distribution.

The last major change that was made in the "to be" model was removing the electronic file that a PCH maintains to keep track of purchase orders and their status. This was eliminated for three reasons: 1) maintaining a personal file does not add value to the customer and is considered a wasteful activity, 2) KFS allows for reports to be generated to keep track of open purchase orders, 3) KFS allows for notes, comments, and attachments to be uploaded in a purchase order. By using KFS as a central repository for notes, status updates, and attachments, all stakeholders involved in the process have access to information and this provides an avoidance of risk of losing information and any one stakeholder having to request information from a single point of failure. When these "islands of information" are eliminated, other stakeholders can obtain the information they need without a wait time of requesting updates from the PCH. This has a potential trickle-down effect of avoiding the use of personally maintained files by other stakeholders since all information is readily available.

Table 6 shows the simulation results of the "to be" model as re-engineered in Savvion. The Savvion model (Figure 5) shows the "to be" process starting with the end user identifying a need until the purchase order is complete. Each activity has an average time to complete and an average associated cost.[3] As depicted in Figure 5, there are four basic swim lanes. Each swim lane represents a stakeholder in the purchasing process. Within each swim lane, each stakeholder performs tasks, which at times, are inter-dependent on the tasks of another stakeholder.

[3] The times and costs were based on subject interviews and average Government Service (GS) levels that are typically hired to perform each function. These averages are based on the personnel at the Naval Postgraduate School and include the locality adjustment.

Table 6. Savvion "To Be" Metrics

Targeted for reduction

Targeted for 1% reduction

Targeted for elimination

Duration	249:22:45 Time

Process	Scenario	Instance	Total Cost ($)	Waiting Time (Time)	Total Time (Time)
ProcurementProcess	(Default)	10	337.50	0:05:00	734:48:45
		Grand Total	**337.50**	**0:05:00**	**734:48:45**

Activity	Performer	Occurs	Waiting Time (Time)	Time To Complete (Time)	Total Time (Time)
AO Review Requisition	Any member of AO	9	0:00:00	0:41:30	0:41:30
Add Addtl Info to KFS	Any member of SPFA	1	0:00:00	0:06:30	0:06:30
Cancel FD Document	Any member of AO	1	0:00:00	0:02:30	0:02:30
Central Location Receipt	Any member of PCH	7	0:00:00	1:11:30	1:11:30
Contact EU	Any member of SPFA	1	0:00:00	0:05:45	0:05:45
Contact EU for Delivery	Any member of PCH	7	0:00:00	0:28:30	0:28:30
Contact EU for Invoice	Any member of PCH	3	0:00:00	0:14:00	0:14:00
Create Hard Copy File	Any member of SPFA	9	0:00:00	0:28:30	0:28:30
Create Hard Copy PCH File	Any member of PCH	7	0:00:00	1:46:30	1:46:30
EU PU	Any member of PCH	7	0:00:00	0:35:30	0:35:30
EU Signs Invoice	Any member of PCH	7	0:00:00	0:35:30	0:35:30
Identify Vendor	Any member of PCH	7	0:00:00	1:48:15	1:48:15
Invoice Received	Any member of PCH	3	0:00:00	0:03:00	0:03:00
Notify EU	Any member of SPFA	1	0:00:00	0:02:45	0:02:45
PCH Contacts Vendor	Any member of PCH	3	0:00:00	0:16:00	0:16:00
PCH Review Requisition	Any member of PCH	8	0:00:00	0:33:45	0:33:45
PickUpItem	Any member of EndUser	7	0:00:00	0:35:00	0:35:00

Activity	Performer	Occurs	Waiting Time (Time)	Time To Complete (Time)	Total Time (Time)
Review Funds Availabiity	Any member of SPFA	10	0:00:00	1:44:45	1:44:45
SPFA Review Requisition	Any member of SPFA	10	0:00:00	0:11:15	0:11:15
Update FD 2	Any member of SPFA	2	0:00:00	0:06:30	0:06:30
Update Files	Any member of PCH	7	0:00:00	1:48:15	1:48:15
AO KFS Approve	Generic	8	0:00:00	0:05:00	0:05:00
AO KFS Disapprove	Generic	1	0:00:00	0:00:45	0:00:45
Approve PO in KFS	Generic	7	0:00:00	0:07:15	0:07:15
Approve in KFS	Generic	9	0:00:00	0:10:30	0:10:30
Assign to PCH	Generic	8	0:00:00	1:30:45	1:30:45
Disapprove KFS Document	Simulation Results	0	0:00:00	0:00:00	0:00:00
Disapprove in KFS	Generic	1	0:00:00	0:01:30	0:01:30
Initiate FD Document	Generic	9	0:00:00	0:28:30	0:28:30
PCH KFS Disapproval	Generic	1	0:00:00	0:00:45	0:00:45
PCH Requisition Receipt	Generic	8	0:00:00	0:05:00	0:05:00
Receive FD Document	Generic	7	0:00:00	0:07:15	0:07:15
Send Increase to PCH	Generic	2	0:00:00	0:02:15	0:02:15
Source in FD	Generic	8	**0:05:00**	0:17:15	0:22:15
Submit Request	Generic	10	0:00:00	0:21:15	0:21:15
Close out PO	Generic	7	0:00:00	4:04:30	4:04:30
Vendor Fills Order	Generic	7	0:00:00	715:41:30	715:41:30

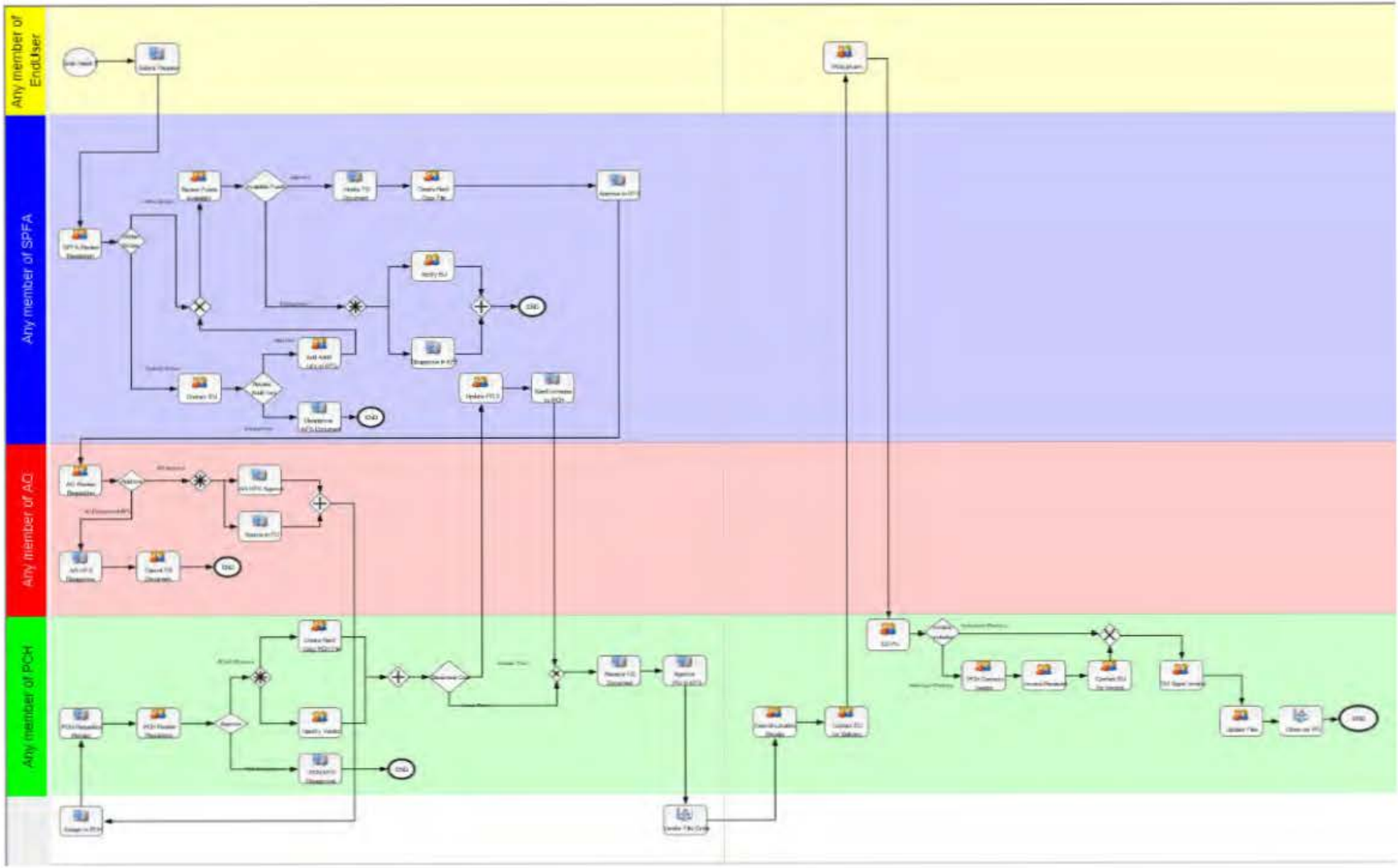


Figure 5. "To Be" NPS Purchasing Model as Modeled in Savvion Process Modeler

Although one bottleneck remains in the workflow when the AO sources the funding document in FD, total wait time has been reduced and all other bottlenecks have been alleviated. The SPFA, AO, and PCH disapproval rates remain the same and the re-engineering has not adversely affected the successful outcome of the end user receiving an item.

C. SUMMARY

The simple changes made to the existing purchase request workflow system resulted in decreased wait time, total time, and cost. While these changes may seem obvious, the documented differences between the "as is" model and the "to be" model show how a few modifications can have a dramatic impact, and have several side benefits as well. These changes have demonstrated how Type Two "efficiency errors" can be nearly eliminated along with their compounding effects. By improving the structure in which the people work with an overarching strategy, savings can be realized which frees those resources to be better utilized in other areas.

V. FINDINGS/RESULTS

A. PRIMARY RESEARCH FINDINGS

The primary research findings are answered by the primary research question, as follows:

1. Can Business Process Re-engineering Techniques Be Used to Improve Micro Purchase Processes at the Naval Postgraduate School and Hence the Government Procurement Processes?

The approach to re-engineering the micro purchase processes is based on the principles of LSS which use data, measurements, and analysis to make improvements. As demonstrated in the results of the "to be" model, it is clear that business process re-engineering techniques can be used to improve micro purchase processes at the Naval Postgraduate School. While these changes are unique to the processes in place at NPS, the structure of BPR can be broadly applied across the government.

B. SECONDARY RESEARCH FINDINGS

In addition to the primary research question and findings, additional questions were addressed that focus on supporting the primary question.

1. What is the Current State-of-the-Art Methodology and Tool for BPR?

The current methodologies adopted by the DON include TQM and LSS. The Naval Postgraduate School has been implementing LSS initiatives across the campus in an effort to improve a broad range of processes. While there are a variety of open market tools available to implement BPR under a LSS technique, no special tools are required as the techniques can be accomplished with standard computer software. However, NPS has an educational license to use Savvion, Inc. software to assist in the development of simulations and models.

2. What is the "As Is" Process Model and System for Government/NPS Micro-Purchases?

The "as is" process model for micro-purchases at NPS starts with the end user identifying a need to fulfill a requirement. There is a variable lead time, depending on the item that is required but the initial steps the end user interacts with include two financial systems, namely, KFS and FD. The SPFA interacts with three financial systems, FD, MAS, and KFS. The AO interacts with KFS to approve requisitions and may or may not interact with FD on a limited basis. The PCH only interacts with KFS.

I. End User

1. Identify a need for an item
2. Validate that the item isn't already available through non-procurement avenues (i.e., available through another department or ITACS, excess through the warehouse, or stored in inventory).
3. Perform market research to locate the item to satisfy the requirement.
4. Identify potential vendors who can provide the item.
5. Initiate a funding document through FD
6. Submit a requisition via KFS
    a. Include the FD document number in the KFS requisition

II. SPFA

1. The SPFA receives the purchase request, reviews all information to include the proposal and funding.
    a. If there are questions, the SPFA will ask the EU for additional information and re-review based on the additional information.
        i. If the additional information does not satisfy the issues, the purchase request is disapproved.
        ii. Financial systems are updated to disapprove the initiation of funds.
    b. Once a requisition is approved, the SPFA updates 3 separate financial systems and via KFS, a notice is sent to the next stakeholder.
    c. If updated funding is required to complete the purchase, the SPFA updates the financial systems and sends the funding to the PCH.

III. AO

1. The AO reviews the requisition for approval or disapproval. Once approved, it is sent to another stakeholder to be assigned to a PCH.

IV. PCH

1. Once the purchase request has been assigned to a PCH, it becomes a purchase order. The PCH reviews the purchase order.
2. The PCH creates a hard copy file of the purchase order, identifies a vendor, and may or may not maintain an electronic log of work in process.
3. If sufficient funding is received, the purchase order is approved and the order is placed with a vendor.
    a. If insufficient funding is received, the PCH contacts the SPFA for additional funding.
4. Once the vendor has shipped the item, it is delivered to a central location and the PCH contacts the EU to coordinate delivery and/or pick up.
    a. If an invoice is included with the delivery, the EU will sign the documentation to accept receipt of the item.
    b. If an invoice is not included with the delivery, the PCH will contact the vendor to obtain the required documentation for the hard copy file. The PCH will coordinate signature of the documentation for a later date.
    c. Once the EU signs for and picks up the item, the PCH updates all records and closes out the PO in KFS.

3. Which BPR Methodology and Tool Are Best Suited to Optimize the Current Process Model and System for Micro-Purchases at NPS?

The BPR methodology that NPS has adopted is the Lean Six Sigma technique for optimizing the current business processes. This decision has been adopted at the senior leadership level and promulgated from the top down. For each LSS initiative, NPS has appointed a team that includes a Project Champion, LSS Black Belt, and various team members to re-engineer identified processes. The decision to re-engineer processes is supported by the DON (Houston & Dockstader, 1997).

C. OTHER FINDINGS

It is important to note that since this is a government entity, there are not any external customers or profits that are generated. In this case study, each stakeholder is essentially a customer to all the other stakeholders as each functional area must work together as a team to accomplish the overarching strategy of the organization as a whole. As quality improves in any one area, it has a direct impact on all other functional areas. The sum quality of all functions produces an overall improvement in quality.

D. SUMMARY

In summary, it is clear that business process re-engineering can improve processes at NPS, utilizing the LSS approach even though profits are not a driving force behind cost reduction. With a shrinking congressional budget and a workflow strategy that is stressed, it is even more critical that processes are performed in the most efficient manner.

VI. CONCLUSIONS, RECOMMENDATIONS, AND AREAS FOR FURTHER RESEARCH

A. CONCLUSIONS AND RECOMMENDATIONS

The focus of this research is to improve efficiency, reduce time, and reduce cost while improving quality of work throughout the workflow process. By using a systematic and methodical approach such as LSS, the micro-purchasing processes have been improved thereby benefiting NPS and the Navy as a whole. While the specific processes are unique to NPS, the methods can be applied and extended to other complex systems.

To address the immediate project of micro-purchasing at NPS, the entire process was deconstructed from the beginning until the end. Each stakeholder was extensively interviewed and each task performed was outlined with an associated average time to complete. The data collected from the interviews was further refined and distilled into key inputs and outputs. The workflow system was evaluated and analyzed through the use of business process modeling software so that bottlenecks could be identified and rectified. The results were measured against two main criteria of time and dollars saved. These results generated a more streamlined workflow system that showed a cost savings of seven percent and a total duration of time savings of about six percent.

The utility of this approach however, goes far beyond the particular case of micro-purchasing at NPS. This approach can be used to further evaluate broader complex operational systems to evaluate efficiency, cost effectiveness, transparency, and quality. This is true because the approach is not unique to a set of attributes rather the approach to improving quality and efficiency is driven by actual data from an organization. In this way, an organization can tailor the workflow system to meet its' needs rather than trying to build business rules around an information system. While the purpose, point in time, and characteristics of any particular complex system are unique, high level analysis rooted in the overall strategy of an organization shares many of the same attributes of which can benefit from a LSS approach. An example of a unique system to solve a problem at a particular point in time is the use of MAS as a financial planning tool. While

this tool was useful at the time, it simply filled a gap and was not evaluated from a strategic point of view. As technology has improved, MAS has become obsolete yet stakeholders still interface with it because it's what they have always known.

B. AREAS FOR FURTHER RESEARCH

While the scope of this research is limited to a narrow subject, the principles on which this research is conducted can be further expanded to include all responsibilities of each stakeholder, specifically the SPFA, AO, and PCH. As one set of bottlenecks is relieved, new bottlenecks may be created as workflows increase. Where a bottleneck may not have previously existed at a particular node, the increased throughput or changes in information systems may affect other related processes. Each of these stakeholders has more responsibilities throughout the day and the micro-purchasing tasks are only one section. By improving one set of responsibilities, further responsibilities can be incorporated into the re-engineering efforts. After the full spectrum of problems/issues have been identified, measured, analyzed, and implemented, further refinements can be made to improve the overall functioning of the school. Once a functional area is working at its' highest form of efficiency, other areas for improvement will become easily identified. In addition to making further refinements and improvements, correlating the total activities of each functional area with other functional areas will yield more opportunities for improvement.

By constantly striving to achieve higher levels of efficiency, new iterations will be required to be evaluated and each evaluation can expect to reveal new areas of potential improvement. This is because any system, especially a complex system, is constantly changing with its environment. Complex systems are dynamic and changes occur formally and informally. Due to these constant changes the system can be thought of as a 'living' system and is not static. Therefore, the systems will require periodic evaluations and refinements. The frequency of evaluation may depend on the degree to which it was changed from a previous state and/or as changes occur in the environment that affect the system.

APPENDIX A. DEMINGS' 14 POINTS FOR THE TRANSFORMATION OF MANAGEMENT

W. Edwards Deming offered 14 key principles for management to follow for significantly improving the effectiveness of a business or organization. Many of the principles are philosophical. Others are more programmatic. All are transformative in nature. The points were first presented in his book *Out of the Crisis*. Below is the condensation of the 14 points for management as they appeared in the book.

1. Create constancy of purpose toward improvement of product and service, with the aim to become competitive and to stay in business, and to provide jobs.
2. Adopt the new philosophy. We are in a new economic age. Western management must awaken to the challenge, must learn their responsibilities, and take on leadership for change.
3. Cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.
4. End the practice of awarding business on the basis of price tag. Instead, minimize total cost. Move toward a single supplier for any one item, on a long-term relationship of loyalty and trust.
5. Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs.
6. Institute training on the job.
7. Institute leadership (see Point 12 and Ch. 8). The aim of supervision should be to help people and machines and gadgets to do a better job. Supervision of management is in need of overhaul, as well as supervision of production workers.
8. Drive out fear, so that everyone may work effectively for the company (see Ch. 3).
9. Break down barriers between departments. People in research, design, sales, and production must work as a team, to foresee problems of production and in use that may be encountered with the product or service.
10. Eliminate slogans, exhortations, and targets for the work force asking for zero defects and new levels of productivity. Such exhortations only create adversarial relationships, as the bulk of the causes of low quality and low productivity belong to the system and thus lie beyond the power of the work force.

- Eliminate work standards (quotas) on the factory floor. Substitute leadership.
- Eliminate management by objective. Eliminate management by numbers, numerical goals. Substitute leadership.

11. Remove barriers that rob the hourly worker of his right to pride of workmanship. The responsibility of supervisors must be changed from sheer numbers to quality.
12. Remove barriers that rob people in management and in engineering of their right to pride of workmanship. This means, inter alia, abolishment of the annual or merit rating and of management by objective (see Ch. 3).
13. Institute a vigorous program of education and self-improvement.
14. Put everybody in the company to work to accomplish the transformation. The transformation is everybody's job. (“The Fourteen Points,” 2014)

APPENDIX B. INTERVIEW QUESTIONS

Each interview conducted with the stakeholders was unique. Follow-on questions were asked based on the previous answers provided. No personally identifiable information or opinions were collected. The interview questions focused on the objective processes for completing procurements from beginning to end. Interview questions generally followed the same format as follows:

1. What is the trigger event that occurs so that you know you have an action to take?
2. What is the very first thing you do?
3. Describe in detail, how you perform each step.
4. What materials are used, if any?
5. Which information systems do you use at each step?
6. If an information system is not used, how do you document a step?
7. Where does documentation reside (either inside or outside of an information system)?
8. How is information relayed to other stakeholders?
9. How are decisions made?
10. What is the purpose of each piece of documentation?
11. How are issues resolved?
    a. What resources do you have?
12. On average, how much time does it take to perform each step for a single procurement?

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF REFERENCES

About NPS. (2014, March 4). Retrieved March 4, 2014, from Naval Postgraduate School http://www.nps.edu/About/index.html

Adopters. (n.d.). Retrieved March 14, 2014, from Kuali Financial System https://www.kuali.org/kfs/adopters

Defense Acquisition Regulation Council. (2014, March 11). 201.201 Maintenance of the FAR. Retrieved March 24, 2014, from http://farsite.hill.af.mil/reghtml/regs/far2afmcfars/fardfars/dfars/Dfars201.htm#P110_4542

Department of the Navy. (2013, December 17). Navy Marine Corps Acquisition regulation supplement. Retrieved January 21, 2014, from Navy Marine Corps Acquisition Regulation Supplement: http://farsite.hill.af.mil/VFNAPSa.htm

El Sawy, O. A. (2001). *Introduction to BPR for e-business.* New York: Irwin/McGraw-Hill.

Finkler, S. A., Ward, D. M., & Baker, J. J. (2007). *Essentials of cost accounting for health care organizations.* Burlington, VT: Jones & Bartlett Learning.

George, M., Rowlands, D., & Kastle, B. (2004). *What is Lean Six Sigma.* New York: McGraw-Hill.

George, M., Rowlands, D., Price, M., & Maxy, J. (2005). *The Lean Six Sigma Pocket Toolbook.* New York: The McGraw Hill Companies.

Government Services Administration, Secretary of Defense, National Aeronautics and Space Administration. (2014, January 1). FAR parts. Retrieved January 21, 2014, from http://farsite.hill.af.mil/vffara.htm

Houston, A., & Dockstader, S. (1997). *Total quality leadership: A primer.* Arlington, VA: Department of the Navy Total Quality Leadership Office..

Gear up: How to model in 20 minutes [internal course AP234 handout]. (n.d.). Retrieved March 13, 2014, from Naval Postgraduate School https://cle.nps.edu/access/content/group/f366ffef-f1de-4941-be59-51c14ed2862b/Course_Documents/Software_Downloads/Savvion_Tutorial/Gear_Up_How_to_Model_in_20_Minutes.pdf

Just-in-time philosophy of complete elimination of waste. (n.d.). Retrieved March 02, 2014, from http://www.toyota-global.com/company/vision_philosophy/toyota_production_system/just-in-time.html

Lombardo, L., Leaver, S., & Walker, J. (2003). *Business-process innovation.* Manhasset, NY: United Business Media LLC.

Mansir, B. E., & Schacht, N. R. (1989). *Total quality management: A guide to implementation.* Bethesda, MD: Logistics Management Institute.

Overview of KFS. (n.d.). Retrieved March 14, 2014, from Kuali Software Solutions for Higher Education: https://www.kuali.org/kfs

Rolstadas, A., & Andersen, B. (2000). *Enterprise modeling: Improving global industrial competitiveness.* New York: Springer.

Savvion; Nissho Electronics releases new SaaS version of their industry leading ACC professional suite based on Savvion BPMS. (2009, July 8). *Electronics Weekly*. Retreived September 24, 2014, from http://www.businesswire.com/news/home/20090622005140/en/Nissho-Electronics-Releases-SaaS-Version-Industry-Leading#.VCXKRMiYa70

Silver, B. (2007, January). Savvion BPM Bridges The Business-IT Divide—Once business users master Savvion's modeling tool, it's easy for IT to turn the designs into executable processes. *Intelligent Enterprise, 10*(1), 16–17.

Suarez, J. G. (1992). *Three experts on quality management: Philip B. Crosby, W. Edwards Deming, Joseph M. Juran.* Arlington, VA: Department of the Navy, Office of the Under Secretary of the Navy, Total Quality Leadership Office.

Taiichi Ohno. (2014, February 21). *Wikipedia*. Retrieved March 02, 2014, from http://en.wikipedia.org/wiki/Taiichi_Ohno

The fourteen points for the transformation of management. (2014). Retrieved March 05, 2014, from https://www.deming.org/theman/theories/fourteenpoints

The system of profound knowledge. (2014). Retrieved March 05, 2014, from https://www.deming.org/theman/theories/profoundknowledge

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California